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ORIGINAL ARTICLE

Assessment of pelvic floor dysfunctions using dynamic magnetic resonance imaging

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Abstract *Purpose:* The purpose of this study was to assess pelvic floor dysfunction using dynamic MRI.
Material and methods: A prospective study was carried out on 21 consecutive patients presented during February 2013 to June 2013 with pelvic pain, difficulty in defecation, constipation or organ prolapse. Pelvic floor was imaged using T2-weighted and fast imaging employing steady-state acquisition sequences. Pubococcygeal line was used as the line of reference which further allowed measurement of width and vertical descent of levator hiatus. Anorectal angle was measured to assess relaxation and contraction of puborectalis muscle. Grading of prolapse was classified as mild, moderate and severe. All data were recorded both in resting and during straining phase.
Results: A total of 21 patients were studied, with a mean age of 37.3 (9.4) years with 15 (71.4%) females and 6 (21%) males. Dynamic MR revealed cystocele and rectocele in 7 (33.3%) patients, each. Three (14.28%) patients had enteroceles and spastic pelvic syndrome, each. Only one patient (4.76%) had descending perineal syndrome. Intussusception was observed in 10 (47.6%) patients with commonest type being intra rectal seen in 7 (33.3%) patients.
Conclusion: Dynamic MRI is an ideal, non invasive technique which does not require patient preparation for evaluation of pelvic floor. It acts as one stop shop for diagnosing single or multiple pelvic compartment involvement in patients with pelvic floor dysfunction.

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1. Introduction

Pelvic floor dysfunction includes spectrum of pathologies such as prolapsed pelvic organs, relaxed muscular pelvic floor, and spastic pelvic syndrome. Patients seek physicians help for variable clinical presentation including obstructed defecation,

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bulging perineal mass, feacal incontinence, tenesmus, constipation and bleeding per rectum.

Descending perineum syndrome was observed in patients with chronic constipation and was first described as relaxed muscular pelvic floor by Parks et al. (1) in 1966. Perineal descent occurs due to excessive straining during defecation, which causes protrusion of anterior rectal wall subsequently leading to incomplete defecation and a weakness of the pelvic floor muscle. Due to incomplete defecation the patient repeatedly strain and already weakened pelvic floor further contributes to perineal descent (1,2).

Pelvic floor dysfunction can manifest as incontinence, constipation, and prolapsed pelvic organs. Patients having constipation and functional anorectal abnormalities complain incomplete evacuation requiring excessive straining or even manual assistance (3).

Pelvic floor weakness is often generalized, therefore all pelvic floor compartments should be evaluated simultaneously (4,5). Surgical correction of single-compartment prolapse is possible, however symptoms recur in 10–30% of patients, and the cause of recurrence often involves compartments that were not repaired initially (6). Thus, the treatment of pelvic floor dysfunction increasingly depends on preoperative imaging (7).

A number of imaging modalities have been used for imaging suspected pelvic floor dysfunction ranging from procedures such as cystourethrography and evacuation proctography to modalities like ultrasonography (8,9). Cystourethrography and evacuation proctography are procedures involving ionizing radiation, while ultrasonography on one hand is operator dependent and on the other hand displays poor soft tissue resolution besides limited field of view (10). Neither of these diagnostic techniques can noninvasively visualize the entire pelvis, nor can they directly image the supporting structures of pelvic viscera (11).

Magnetic resonance (MR) imaging emerged as a non invasive alternative with multiple advantages like non ionization procedure and displaying images in multiple planes with superior soft tissue resolution. These features are specifically suitable for those patients with multi-compartment involvement and for those who have undergone previous surgeries (6).

Rapid-sequence dynamic magnetic resonance imaging (MRI) provides exceptional images of the pelvic organs and soft tissue supporting structures. It is fast, noninvasive, and requires no patient preparation (12).

Dynamic MR Images obtained in neutral position, during squeezing, straining, and defecation have a central role in the diagnosis of pelvic floor dysfunction, therefore clearly identifying candidates for surgical treatment (13).

The aim of the present study was to assess pelvic floor dysfunction using dynamic magnetic resonance imaging.

2. Material and methods

A prospective study was carried out from February 2013 to June 2013 in the department of Radiology at Dallah Hospital, Riyadh. Twenty-one consecutive patients presenting with pelvic pain, difficulty in defecation, constipation or organ prolapse underwent dynamic pelvic MRI.

Human ethics committee approval for this study was obtained from the institutional review board of Dallah Hospital.

All MRI scans were performed using MRI scanner (Optima™ MR 450 W 1.5 T). Informed consent was taken from all patients. MR imaging protocol required no oral or intravenous contrast agents. No bowel preparation was carried out. All patients were instructed to empty their urinary bladder about 3 h before the examination to achieve a medium filling of the bladder during MRI. The rectum was filled with 120 ml warm ultrasound gel, introduced into the rectum through a flexible catheter, with patient lying in lateral decubitus position on the scanner table.

First set of images obtained was volumetric sagittal cuts used to locate the mid-sagittal plane at the level of the symphysis pubis and to review the pelvic anatomy. Second set of images was obtained as four cycles of relaxation and straining.

The dynamic MRI examination preceded sequences for imaging pelvic anatomy and any muscle defects, such as thinning and tears. For this purpose, T2-weighted thin-section sequences (repetition time/echo time; 300/102 ms, field of view; 23×23-cm and matrix 384×224) were acquired with 25 sections having 5-mm section thickness. Image acquisition time was 3–4 min. Images were acquired in axial, sagittal, and coronal planes.

Dynamic imaging was performed by using a steady-state sequence, fast imaging employing steady-state acquisition (FIESTA). Parameters used were repetition time /echo time; 4.8/2.4, field of view; 40×40-cm, and matrix; 224×288. Section thickness was 8-mm. Data was acquiring one section per second in the mid-sagittal plane at rest, during maximal sphincter contraction, straining, and defecation.

Patients were asked to relax initially and then to perform straining maneuvers to empty the rectum as completely as possible. Acquired sequences were later analyzed in cine mode.

The size of the levator hiatus and degree of muscular pelvic floor relaxation and organ prolapse were measured. The pubococcygeal line (PCL) was drawn from the pubis to the inferior coccygeal joint. The H-line (levator hiatus width) measures the distance from the pubis to the posterior wall of rectum. The M-line (muscular pelvic floor relaxation) measures the descent of the levator plate from the pubococcygeal line (Fig. 1). Normal cut off for H and M lines was taken as 5 cm and 2 cm in length, respectively (14).

Measurement of prolapse was based on grading system suggesting severity as mild, moderate and severe. Degree of

Fig. 1 Sagittal FIESTA image displays PCL (white line) drawn from the inferior border of pubic symphysis to the lower most coccygeal joint. H line (white dotted line) extends from the inferior border of pubic symphysis to the posterior rectal wall. M line (red line) is drawn perpendicularly from PCL to the most posterior aspect of H line.

prolapse below the PCL by 3 cm or less was graded as mild, between 3 and 6 cm as moderate, and more than 6 cm as severe. Anorectal angle was also measured keeping normal values between 108° and 127° at rest, with an increase of about 15–20° on defecation (14).

3. Results

A total of 21 patients were included in our study with a mean age of 37.3 (9.4) years. Out of 21 patients, 15 (71.4%) were females and 6 (21%) were males. Dynamic MR images revealed cystocele and rectocele in 7 (33.3%) out of 21 patients, each. Three out of 21 (14.28%) patients had enteroceles and spastic pelvic syndrome, each. Only one patient (4.76%) had descending perineal syndrome. Intussusception was observed in 10 (47.6%) patients with commonest type being intra rectal seen in 7 (33.3%) patients.

One (4.76%) patient had anorectal and 2 (9.97%) had intra anal intussusceptions. Anorectal angle paradoxically narrowed on straining in 3 (14.28%) patients suggesting spastic pelvic syndrome.

Degree of prolapse below pubococcygeal line was graded as mild, moderate and severe in 2 (9.52%), 14 (66.6%) and 2 (9.52%) patients, respectively.

Six (28.5%) out of 21 patients displayed abnormalities involving more than one pelvic compartment.

3.1. Statistical analysis

Statistical analysis was done with SPSS, statistical package (SPSS, Version 17.0).

4. Discussion

We prospectively studied a total of 21 patients presented to the Radiology department with clinical suspicion of pelvic floor dysfunction. MR imaging was carried out using MRI scanner Optima™ MR 450 W 1.5 Tesla with phased-array coil.

Multiplanar T2 weighted images were obtained before carrying out dynamic FIESTA sequences. Complex anatomical structures of pelvic floor were readily appreciated on T2 weighted images, which helped to review the anatomical details and their relationships. Moreover multi planar imaging helped in identifying the anatomical landmarks in all planes, thereby helping in evaluation of intricate muscular and fascial anatomical details.

Dynamic MR imaging of pelvic floor was carried out by using a steady-state, fast imaging employing steady-state acquisition (FIESTA) sequence, acquiring data in the mid-sagittal plane at rest, during maximal sphincter contraction, straining, and defecation. One image per second was acquired with multiple images being evaluated in cine mode afterward. Sagittal midline FIESTA images were used to draw important land marks including pubo-coccygeal, H and M lines. Pubococcygeal line was drawn extending from inferior border of pubic symphysis to the lower most coccygeal joint. Using PCL as base line, other two important lines named H and M lines were evaluated to outline antero-posterior width and vertical descent of levator hiatus, respectively (Fig. 1). H line was drawn from the inferior border of pubic symphysis to the posterior wall of rectum with a normal measurement not

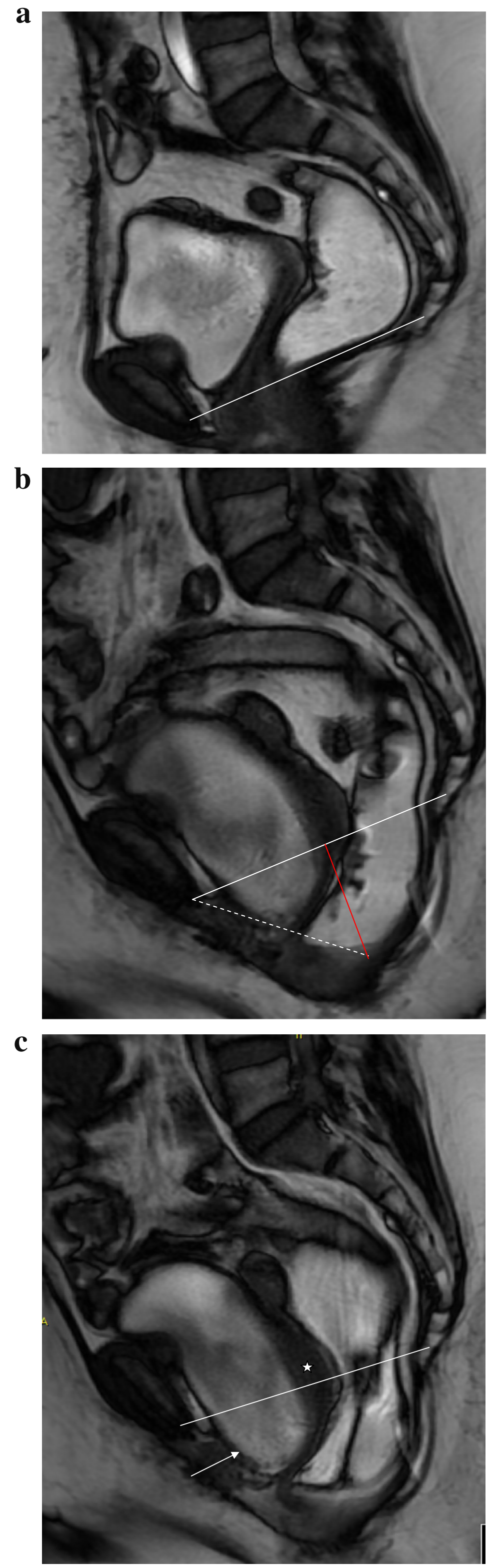

Fig. 2 Sagittal FIESTA images obtained (a) at rest and (b, c) during straining and evacuation. At rest, displays normal anorectal configuration with continent anal sphincter and no spillage of rectal contrast. Evacuation phase shows descent of anorectal junction below the pubococcygeal line, anterior rectocele as well as minimal intrarectal intussusception. In addition cystocele (white arrow) associated with enterocele (white star) is evident.

exceeding 5 cm (14). M line was drawn as a vertical line extending perpendicularly from PCL to the posterior limit of H line, with a measurement of 2 cm considered as normal (14).

Cystocele by definition is descent of base of urinary bladder below the border of pubic symphysis (3). We observed that in patients with cystocele, the base of urinary bladder when descends downwards, partially inhabits levator hiatus, thus causing displacement of uterus posteriorly and anorectal junction inferiorly. It was clearly manifested as increase in dimensions of H and M lines (Fig. 2).

Vaginal and cervical prolapse was considered when vaginal vault and cervix herniated inferiorly below PCL (15,16). Dynamic images displayed descent of organs of middle compartment below the pubococcygeal line with subsequently elongated H and M lines.

Abnormal bulging of rectal wall beyond anterior or posterior anorectal margin was labeled as rectocele and was appreciated in 7 (33.3%) of our patients (Figs. 2 and 3).

Three (14.28%) patients in our study had enteroceles, displaying the presence of small bowel loops in recto-vaginal pouch. Enteroceles associated with peritoneoceles were also appreciated in few cases (Fig. 4).

Full thickness rectal wall prolapse was yet another observation made in our study, with patients presenting as mechanical obstruction to defecation. Dvorkin et al. describes 70% sensitivity of MR defecography in diagnosing intussusception (17). In our study, 10 (47.6%) out of 21 patients were diagnosed as having rectal wall prolapse (Fig. 4). Eight (80%) out of these patients were females, which is in accordance with the study by Fengler et al. (18). Seven (33.3%) of our patients had intra-rectal intussusception, which was the commonest type in our study (Fig. 4).

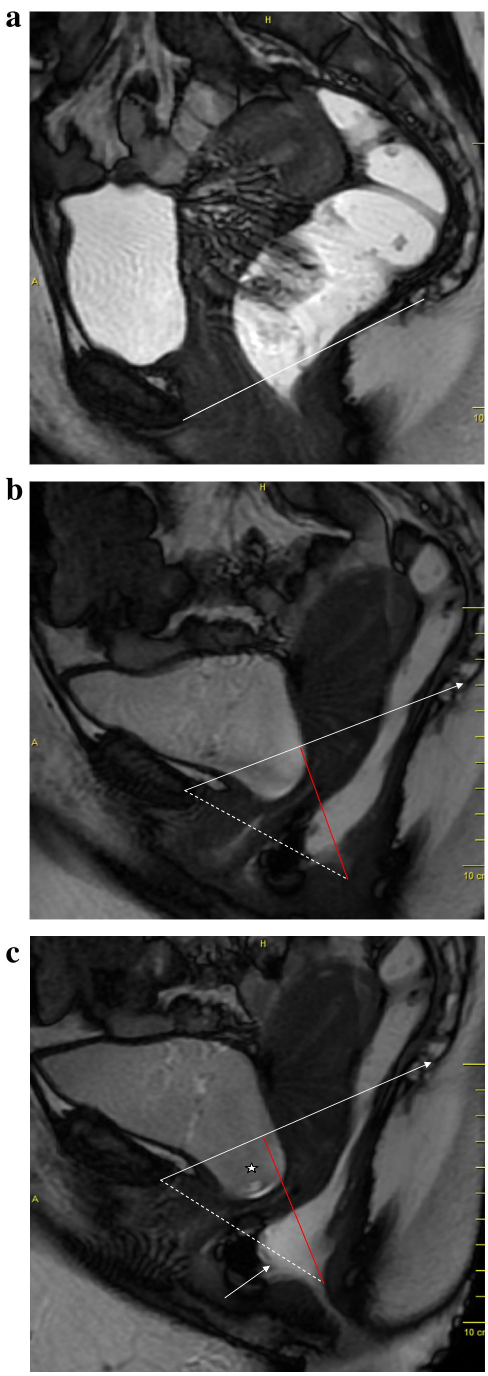

Fig. 3 40 year old female, presented with obstructive defecation post sphincterotomy. Sagittal FIESTA images (a) at rest displays normal anorectal configuration with no signs of descent, (b) at evacuation, displays good expel of contrast, anorectal descent 5.5 cm below pubococcygeal line with anterior rectocele (white arrow) and cystocele (white star).

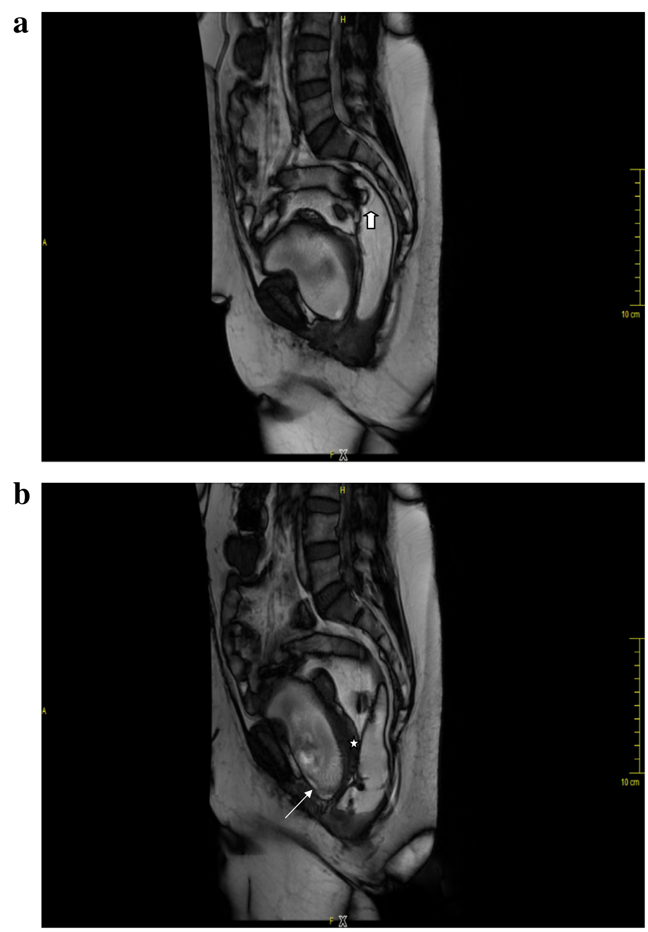

Fig. 4 Sagittal FIESTA images displaying moderate pelvic floor weakness involving two compartments, depicted as 3 cm cystocele (white arrow), peritonecele with enterocele (white star) and intra rectal intussusception (broad arrow).

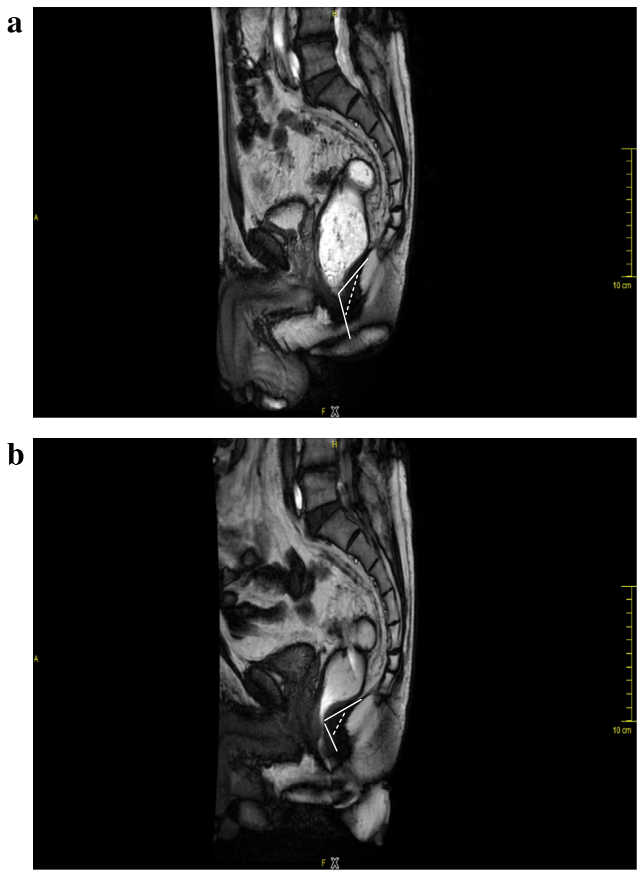

Fig. 5 Sagittal FIESTA images obtained (a) at rest and (b) during evacuation displaying spastic pelvic syndrome. During evacuation, the anorectal angle (white dotted line) narrows failing opening of anal sphincter, due to paradoxical contraction of the puborectalis muscle.

Anorectal angle was measured by defining anorectal junction, which is a point of transition between distal part of rectum and anal canal. Anorectal junction is taken as the apex of anorectal angle, which helped in identifying the functioning of puborectalis muscle. Comparison of dynamic images during rest and straining clearly depicted the narrowing of anorectal angle in later sequences. Measurement of anorectal angle helped in identifying pelvic spastic syndrome. Only 3 patients in our study had pelvic spastic syndrome. Comparison of MR images at rest and during straining displayed involuntary, paradoxical contraction of puborectalis muscle thus manifesting as prolonged and incomplete defecation in all the 3 patients. Absence of pelvic floor descent was observed to be associated with paradoxical contraction of puborectalis muscle, which did not allow opening of anorectal angle (Fig. 5). Narrowing of anorectal angle was seen during straining and evacuation as compared to the angle observed in resting state.

Pelvic floor dysfunction is frequent but complex condition that can involve one or more pelvic viscera (3). In our study, 6 (28.5%) patients had abnormalities of more than one pelvic compartment (Fig. 4). In our experience, dynamic MRI of the pelvic floor was increasingly useful in diagnosing complex pelvic floor disorders and multi-compartmental involvements.

5. Conclusion

Dynamic MRI is an ideal, non invasive technique which does not require patient preparation for evaluation of pelvic floor. It acts as one stop shop for diagnosing single or multiple pelvic compartment involvement in patients with pelvic floor dysfunction.

Conflict of interest

The authors have no conflict of interest to declare.

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